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ABSTRACT

Recent advances have been made in facilitating implementation of Ausubel's advance organizer strategy. One reason Ausubel's approach has not been widely adopted is its lack of specificity about how to relate what is to be learned to what has already been assimilated within the cognitive structure. The use of subsumptive sequencing, coordinate linkages, and the activation of appropriate generic or cognitive skills are three approaches for providing anchorage for the assimilation of new knowledge. Subsumptive sequencing has to do with arranging material to be taught in a hierarchical relationship, coordinate linkage has to do with arranging material to be taught in a co-ordinate relationship, and activating appropriate cognitive skills has to do with arranging material to be taught in an analogic relationship. Instantiation and elaboration are strategies for emphasizing hierarchical relationships, while comparison/contrast and synthesis emphasize co-ordinate relationships, and the use of analogies and metaphor emphasize analogic relationships. Specific procedures have been developed for implementing each of these strategies. (LLS)

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RELATING WHAT IS TO BE LEARNED TO WHAT IS KNOWN:

SUBSUMPTIVE SEQUENCING, CO-ORDINATION, AND COGNITIVE SKILLS ACTIVATION

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Relating What is to be Learned to What is Known:

Subsumptive Sequencing, Co-ordination, and Cognitive Skills Activation

One of the most important functions of instruction is to assist learners in relating new content to existing cognitive structures. Ausubel's development of the advance organizer was an attempt to serve this function, but the approach has not been widely adopted for a variety of reasons, including a lack of specificity about different ways in which such relationships can be made or facilitated. This paper reports on some recent advances in the detailed specification of three different ways of effecting relationships between what is to be learned and what has already been assimilated within cognitive structure. These three methods are the use of subsumptive sequencing of instructional content, the use of coordinate linkages between content constructs, and instruction in and activation of appropriate generic or cognitive skills for manipulating and processing unfamiliar content (see Figure 1).

Insert Figure 1 about here.

Ausubel's work on the nature of meaningful learning emphasizes the centricity of the learner's cognitive

structure in the acquisition of skills and knowledge (Ausubel, 1964; 1967). The act of "making meaningful" requires both the potential for relatability in the content to be learned and the potential for relating that content within the learner. Meaningful learning is a constructive process, in which linkages between external and internal content structures must be carefully and consciously built by the learner (see Figure 2). The conscious nature of this process requires an intent on the learner's part to make relationships and connections; as previously stated, that intent is delimited by the quality, quantity, and stability of the constructs and links already present within cognitive structure.

Insert Figure 2 about here.

Ausubel has suggested the use of advance organizers, which are general constructs of greater abstractness and inclusiveness than the constructs to be assimilated; he maintains that introductory use of such content provides ideational anchorage for the constructs to be learned. However, the advance organizer has come under fire as being difficult to operationalize and research results are often non-replicable. What appears to be needed is a more precise means of analyzing the types of relationships that can and do exist among constructs in a subject area and a more precise set of strategies for assisting learners in

perceiving and using those relationships as strategies for learning. Thus, the call is for a greater variety of well-defined strategies to aid in the process of meaningful learning.

What we wish to discuss today is not new or different from the lines of research and theory-building that have characterized cognitive psychology over the past several decades. Rather, we offer a reanalysis and synthesis of several lines of work on models of instruction and a set of prescriptions for the organization of instruction that take into account the relationships among content in a subject area. We can begin with a brief description of the lexicon in which these relationships and strategies will be described.

Merrill's (Merrill and Wood, 1974) work on a taxonomy of instructional variables has delineated two major kinds of instructional elements: an instance, a specific object or event (or its representation) which exists or could exist in the real world; and a generality, a statement of a definitional or propositional relationship which can be applied to more than one object or event (i.e., instance). For example, the concepts "literature", "poetry", and "sonnet" are all generalities, while "Shall I Compare Thee To a Summer's Day" is an instance of all three generalities. On the basis of analysis of the type of operation involved in deriving the element (identity, descriptive, or productive) and the meaningful or rote nature of the

operation, Merrill (Reigeluth, Merrill, and Bunderson, 1978) has identified five major types of subject matter content or constructs: facts, subsets, concepts, procedures, and principles.

Moreover, with the exception of facts, each of the content types can be manipulated at three different task levels: remember, use, and find. For example, one can remember the definition of a concept (the set of critical attributes) or an familiar instance of that concept, or one can use the definition to classify unfamiliar instances, or, given a set of instances, one can identify and use the common attributes to form a concept definition which characterizes their identity as a set (see Figure 3.).

Insert Figure 3 about here.

Accordingly, considerations of content element, content type, and task level can be used to characterize subject matter constructs individually and in relationship to each other. Analyses of the individual constructs and their relationships to each other lead to prescription of instructional strategies that are specific to the type of construct or relationship that must be acquired by the learner. Moreover, it is our hypothesis that learning increases to the extent that learners are helped to understand not only that constructs in a content area are related, but also how they are related. Relationships

between familiar and unfamiliar content can be identified as being one of two major types ---hierarchical or coordinate. Each type can take several forms (see Figure 4).

Insert Figure 4 about here.

RELATIONSHIPS

Hierarchical Relationships. Hierarchical relationships exist between generalities and their instances and among generalities.

Generalities and Their Instances. A generality --- a concept, procedure, or principle--- explains, classifies, or relates groups of natural phenomena. Generalities are hypothetical, even though their expression may have acquired the status of convention or standard among large groups of people. The instances of a generality have existence in the real world and function to make the generality meaningful. Thus, a child learns the generality "hot" by touching things (instances) of varying degrees of warmth and associating the sensation of each with the concept. The instances become associated with the concept and the concept with the instances. In order to be able to use the concept to classify new instances, the child must encounter many different instances which exhibit differing values of the attribute "temperature" and must learn to judge which of

those instances fall within the parameters defining membership in the "hot" class. Thus, the generality becomes meaningful and usable only through multiple instantiation.

Generalities and Generalities. Hierarchical relationships also exist among generalities. The most broadly applicable of these hierarchical relationships is the taxonomy. In taxonomic relationships, higher-order generalities subsume lower-order generalities, which in turn subsume even lower-order generalities. For example, "literature" subsumes "poetry" which in turn subsumes "sonnet". At the apex of the taxonomy is the most general, abstract, and inclusive generality; at progressively lower levels, the generalities become more specific, concrete, and limited. Equally, the set of acceptable instances becomes smaller at each lower level of the taxonomy. The set of instances for the generality "vertebrate" is much larger and has broader critical attributes, than the set of instances for the generality "dog", which in turn is larger than the set for the generality "spaniel".

The taxonomic structure utilizes two kinds of relationships among generalities; one generality may be a part or a kind of another higher-order generality. For example, we can talk about the parts of a poem (stanzas, lines, imagery, and theme) or the kinds of poems (sonnets, odes, ballads, or limmericks).

Each type of generalizable content can be represented in parts or kinds taxonomies. Principles are composed of

parts which are concepts; several different kinds of more specific and concrete principles may be subsumed under a highly abstract, general principle. Higher-order concepts are defined in terms of attributes which are themselves lower-order concepts; also, lower-order concepts are parts or kinds of higher-order ones. And general procedures subsume more specific lower-order procedures and are composed of parts or steps (see Figure 5).

The structure of content in a subject matter area can thus be analyzed into the kinds of relational components ---the kinds of content--- and the nature of relationships among those components. Both the individual constructs and their relationships can and should be taught.

Insert Figure 5 about here.

Co-ordinate Relationships. Co-ordinate relationships among instances and among generalities are another important and useful type of connection. Co-ordinate relationships can be made in three ways.

Co-ordination among Instances. Instances of the same generality have co-ordinate relationships whose emphasis during instruction can enhance learning of the generality. Even while they share a common set of attributes, instances differ from each other in two ways, first in the levels or values of their shared attributes (for concepts) or the appropriate contexts for application (for procedures or

principles) and second in non-shared but distracting components of attributes or contexts. Identification and use of similarities and differences among instances of a generality assists learners in increasing their ability to generalize beyond the instances provided during the instruction (see Figure 6).

Insert Figure 6 about here.

Co-ordination among Generalities. Generalities have co-ordinate relationships with each other, as parts or kinds of higher-order, subsuming generalities. Fitting a new generality within the learner's existing knowledge involves linking it both hierarchically and laterally to already familiar constructs. For example, the three kinds of sonnets ---Shakespearean, Petrarchan, and Spenserian--- are kinds-coordinates under the more general concept "sonnet". The more familiar Shakespearean can be used to anchor the other two less familiar kinds through comparison and contrast. The more links and the more kinds of links among generalities a learner is able to make, the more firmly the new construct will be anchored and retained. At the same time, generalities must be demonstrably separate from each other or obliterative subsumption (Ausubel, 1967) will occur. The instructional identification of co-ordinate linkages ---similarities and differences--- among generalities at the same taxonomic level may help to prevent

obliterative subsumption (see Figure 7).

Insert Figure 7 about here.

Analogic Relationships. The preceeding discussion has focused on types of relationships among constructs within a single subject-matter area. However, subject-matter areas can and should be related to one another, by means of analogy and metaphor. Such analogic statements create co-ordinate linkages among generalities of different areas; they can be useful whenever the constructs to be taught are so new and unfamiliar to learners that no subsuming or co-ordinate constructs are available from the learner's prior knowledge and experiences within the subject matter area to be learned to provide ideational anchorage. An analogy creates co-ordination between two normally very dissimilar constructs; it is useful for producing comparative transfer of crucial qualities from one construct to another. To help learners understand the dynamic nature of a city, a sociology professor can compare the city to a living organism; this analogy to a familiar biological construct can immediately and vividly articulate the crucial characteristics of a city in recognizable terms for learners (see Figure 8). It is a dramatic, cogent, and useful means of explication, and one which is too seldom used in instruction.

Insert Figure 8 about here

Activating Cognitive Skills. Equally important is the instructional identificatcn of the kinds of relationships that exist among the various types of constructs. Instruction should make explicit the relationships among component concepts of a principle, defining how the concepts relate (as parts of the whole) and how the lower-order, more specific principles are special cases (kinds) of the higher-order case. Instruction should make explicit the relationships among attributes of a concept and how the lower-order concepts are parts (attributes) or kinds (special cases) of the higher-order case. And instruction should make explicit the relationships among the steps (parts) of a procedure and how the simpler, more specific lower-order procedures are special cases (kinds) of the higher-order one. Thus instruction should not only identify and use hierarchical and co-ordinate relationships among constructs as the basis for organizing the instruction, but also make explicit what those types of relationships are which can exist among various types of constructs and how learners can use them to manipulate content on their own.

Therefore, one additional kind of linkage merits discussion. The analytic and constructive activities by which designers and teachers identify constructs and relationships can be considered as constituting another kind of subject-matter area of equal importance in school

learning. Generic or cognitive skills, such as definition, description, taxonomizing, and metaphor-making, represent a critical kind of knowledge which must also be meaningfully acquired during schooling. If we consider these skills as constituting a separate subject-matter area, we can see that they exist as generalities for which instances can be identified, that they can be used at all three task levels (remember, use, and find), and that they consist of all five types of constructs (facts, subsets, concepts, procedures, and principles). Thus, hierarchical and lateral relationships among these skills can be identified and used for instruction in these skills . Equally important, these skills, once acquired, can be activated as another means of clarifying constructs in any subject-matter area. A construct in an area such as biology can be made meaningful for learners by instructional methods which explicitly identify the construct as an instance of the skill-generality. Thus, a taxonomy of plants can be taught both as a set of biological constructs and as an example of taxonomizing. Explication of both the biological construct and the skill construct increases the types of ideational anchorage available for the plant taxonomy. A model airplane and a blueprint of a house can instantiate the concept "model"; the skill of model-building can be activated to help make meaningful the nature of an instructional model (see Figure 9). Thus, the activation of familiar cognitive skills and the identification of specific

constructs (from the desired subject area) as instances of the use of those skills enhances the learning of the desired subject matter area.

Insert Figure 9 about here.

STRATEGIES

The identification and use of hierarchical and co-ordinate relationships among constructs is an important strategy for designing instruction. Specific organizational strategies can be specified for using each type of relationship to facilitate meaningful learning.

Strategies for Emphasizing Hierarchical Relationships.

To teach an individual construct, the primary strategy is instantiation. A generality is meaningful acquired to the extent that it is tied to referrents in the real world. Instances should be selected to meet the following criteria. First, a large enough set of instances should be selected to represent a sampling of the range of types of possible instances. The instances should be divergent (demonstrably different) on several nonrelevant components. The set should be sufficiently large to permit slow learners to acquire the construct. The set should represent a range of levels of difficulty, from very easy to very difficult. The set should include both familiar and unfamiliar instances.

Finally, instruction should continue on any one generality until the learner is able to generalize to the range of possible instances beyond those provided for instruction.

Component Display Theory (Merrill, in press) contains a set of strategy prescriptions for utilizing instances. Included are strategies for selecting and sequencing instances across a range of difficulty levels, for utilizing instances which are divergent on noncritical attributes, and for matching instances with noninstances.

To teach a set of related constructs, the primary strategy is elaboration. A set of generalities is more effectively learned to the extent that the relationships among the members of the set are explicated and used as learning strategies. The most superordinate constructs should be taught first, and linked to constructs already familiar to learners. Then the set of generalities which represent parts or kinds of that superordinate generality should be taught next. Each second-level generality should be taught explicitly in terms of its relationship to the subsuming generality. Each should be instantiated separately. Third, the next level of elaboration should present generalities which are parts or kinds of each separate second-level generality; again, the parts or kinds relationship for each hierarchical link should be made explicit and instantiation should occur for each generality separately. This progressively elaborated organizational structure should constitute the basic form of the instuction

and should continue until all generalities have been taught in terms of their hierarchical relationships to each other.

The Elaboration Theory (Reigeluth, 1979) prescribes strategies for utilizing an elaborated hierarchy of subject matter constructs. Included are strategies for identifying key constructs to be taught and their orientation (conceptual, procedural, or theoretical), for constructing a hierarchy of content within that orientation, for presenting that hierarchy in terms of a series of levels of increasing detail and specificity, and for synthesizing and summarizing each level of the elaborated structure before proceding with next level (see Figure 10).

Insert Figure 10 about here.

Strategies for Emphasizing Co-ordinate Relationships.

In instruction on a single generality, the primary strategy is comparison and contrast among instances. Instances should be presented in terms of their shared critical attributes as well as in terms of non-shared attributes or irrelevant components. The set of instances should represent the range of acceptable values on critical components, while being as divergent as possible on non-critical components. Practice in distinguishing between acceptable and nonacceptable instances should also be provided.

Component Display Theory (Merrill, in press) prescribes

the use of matched noninstances and divergence to faciliatate meaningful acquisition of the generality and to prevent application errors.

For instruction on a set of related generalities, the principal strategy is synthesis at the conclusion of instruction at each level of elaboration. The set of generalities constituting a particular level should be presented in terms of their relationships to each other (co-ordinate kinds or parts) and those characteristics distinguishing one generality from another explicated. At this stage, an expanded taxonomy containing both hierarchical and co-ordinate linkages should also be a topic of instruction. Learners must be able to reinforce or correct their understanding of how generalities relate to each other as well as to their instances and to other generalities with which they were previously familiar. Instruction at the next level of elaboration should not begin until learners can demonstrate their understanding of relationships at that particular level (see Figure 11).

Insert Figure 11 about here

The Elaboration Theory (Reigeluth, 1979) calls for presenting (1) a simplified version of the synthesizer for a lesson before the lesson, and (2) a complete version of the synthesizer for a lesson after the lesson.

Strategies for Relating Extremely Unfamiliar Content.

Occasionally, the content to be learned may be so novel or unfamiliar to learners that no subsuming or coordinating construct within that subject matter area is available in the learners' cognitive structure to anchor the new knowledge. In such cases, the principal strategy is the use of analogy and metaphor by which a construct in some other subject area serves to familiarize the construct of interest. An analogy or metaphor serves as a "far" coordinate link between the constructs of interest and some other subject area through a kinds relationship. The familiar construct and the new construct are presented as sharing certain characteristics which are familiar to the learner. The learners' knowledge of the shared characteristics is used to familiarize the new construct so that the new construct can be meaningfully placed within the construct hierarchy in the subject area of interest. Thus, the analogy or metaphor is utilized to explicate the salient characteristics of the new construct so that the new construct becomes meaningful (see Figure 12).

Insert Figure 12 about here.

Strategies for Emphasizing the Structure of the Content. Concommitant with instruction on the constructs of interest in a particular subject matter area, there should also occur instruction in the nature of the structure of that area and in skills for deciphering and using that structure. Once

generic cognitive skills have been acquired, learners should be directed by the instruction to activate those skills in order to examine how constructs relate to one another and in order to continue identifying and using those relationships on their own. Cognitive skills should be practiced, using the subject area of interest as instance pool. Instruction should emphasize how to analyze, or define, or construct analogies, as well as how to use the fruits of such activities performed by designers and teachers. Instruction should have dual goals of competence in a particular content area and competence in critical thinking and problem-solving.

The primary strategy for emphasizing acquisition of relationships is activation of previously learned cognitive skills and instruction, as needed, in new skills (see Figure 13). Several models of cognitive skills instruction exist; the reader is referred to Gagne and Briggs (1974) and O'Neill (1978) as examples.

Insert Figure 13 about here.

PROCEDURES

Procedures for Emphasizing Hierarchical Relationships

Procedures for Relating Generalities and their

Instances. Component Display Theory provides the model for structuring a lesson to teach a single construct (concept, procedure, or principle). Four prescriptions relate directly to the use of instances (see Figure 14). First, instances should be selected which represent a range of levels of difficulty; easy or familiar instances should be presented before unfamiliar or difficult ones. Moreover, both instructional instances and practice instances should appear in easy-to-difficult sequences.

Insert Figure 14 about here.

Second, the instances should be divergent with respect to noncritical components so that learners can be helped to avoid undergeneralizing or overgeneralizing the construct. For procedures and principles, contexts of instances should be varied on at least two dimensions; for concepts, noncritical attributes should vary on at least two dimensions.

Third, instances and feedback for instance practice should contain attribute isolation so that the salient characteristics of the instances are separated and emphasized for ease in perception. Algorithms and mnemonics should be used to assist learners in structuring their analysis and employment of instances.

Finally, instances should be presented for both instruction and practice in a variety of representational

forms. Verbal, pictorial, and diagrammatic representation of instances provide learners with additional modes for relating instances to generalities since different representational forms cue different memorial structures and retrieval strategies (For a detailed sequence of procedures for implementing the strategy of instantiation, see Merrill, Reigeluth, and Faust, 1979).

Procedures for Relating Generalities. Elaboration Theory delineates a set of procedures for structuring instruction on a set of generalities. There are three basic strategies for developing an elaborated structure of content within a subject area (see Figure 14). First, an orientation structure must be selected that is congruent with the course goals and objectives. The orientation may be conceptual, procedural, or theoretical. Using that orientation, the constructs constituting the course are then delineated and intra-construct relationships are specified. The result of this effort is a taxonomy of the key constructs to be taught. Higher-order, more inclusive constructs occupy the top portion of the taxonomy and are used instructionally to anchor the lower-order, less inclusive constructs in the lower portions of the taxonomy through the process of subsumption. The orientation structure determines the kinds of strategies to be utilized in developing the elaborated structure.

Second, the epitome should be constructed. The epitome

is a synthesizing set of constructs which summarize, at a very general level, the entire content structure to be taught. It portrays only the most important aspects of the orientation structure, and its related supporting structures. An epitome is like an overview, but it is derived from an orientation structure and is taught through the strategy of instantiation.

Third, the elaboration structure must be constructed in layers of increasing detail and complexity. The superordinate constructs are the most general and simple; each succeeding layer adds complexity and detail to ---elaborates on--- the layer before it. The complete elaboration structure contains all the subject matter constructs and their interrelationships in the area. Each level of elaboration is taught separately by developing parts or kinds relationships among its constructs and the superordinate constructs of the previous (higher) level, by identifying the parts-coordinate or kinds-coordinate relationships among the constructs within that level of elaboration, and by instantiating each construct individually (For more detailed information on the construction of elaborated content structures, see Reigeluth, Merrill, Wilson, and Spiller, in press; and Reigeluth and Rogers, 1980).

Procedures for Emphasizing Co-ordinate Relationships

Procedures for Relating Instances within a Single Generality. The procedure consists of three strategies (see Figure 14). First, matched instances and noninstances should be presented together during instruction so that learners can be made aware of the importance of attending to both critical and noncritical aspects of the instances. Second, alternative representations of instances should be used to assist learners in avoiding undergeneralizing to instances in different representational forms. Finally, instances which are divergent on several noncritical aspects should be utilized to help learners avoid undergeneralizing (For more detailed information on the selection and sequencing of instances, see Merrill, in press).

Procedures for Relating Generalities at the same Level of Elaboration. There are three strategy components in building instruction that elucidates co-ordinate relationships among generalities (see Figure 14). First, the type of relationship ---kinds or parts--- should be made overt and the attributes or elements which separate the different generalities should also be articulated. Thus, the higher-order construct should be used to anchor the various lower-order parts or kinds; then comparison and contrast among the lower-order constructs should be used to identify their uniquenesses and their co-ordinate relationships. Second, the instruction on each level of elaboration should commence and conclude with the relational

structure, in the form of an internal synthesizer which articulates the parts or kinds relationships in advance of and after instruction on each separate generality within that level. Third, an external synthesizer should be provided at the conclusion of the entire layer of elaboration to relate that layer to the orientation structure as a whole. Thus, by building co-ordinate relationships within each level of elaboration and hierarchical relationships among levels of the elaboration, relationships among generalities are elucidated and taught.

Procedures For Relating Generalities Across Subject Matter Areas. The analogy provides the basis for the strategy for relating generalities from different subject matter areas (see Figure 14). The familiarizing analogue must already exist in cognitive structure, or be aquired prior to its use. There are three strategies involved in using analogies. First, the familiar analogue must be of the same content type (concept, principle, or procedure) and at the same level of generality and inclusiveness as the content it is intended to familiarize. Second, the critical attributes of the familiar analogue should be articulated and compared with the similar critical attributes of the new content. Third, the instruction must make the learner aware of the limitations of the analogy (aspects where the analogy breaks down). The analogy is most useful when it familiarizes several related constructs. Therefore, the

instructional analogy (familiarizer) is a tool for providing ideational scaffolding for extremely unfamiliar content which has no within-subject-matter-area anchorage available.

Procedures for Activating Cognitive Skills. There are two methods for activating cognitive skills during instruction (see Figure 14). Instruction may either require the student to perform a given cognitive skill in order to produce a desired response or instruction may tell the learner to use a skill rather than produce an answer. Rigney (1978) refers to the former as an embedded strategy and the later as a detached strategy. To use an embedded strategy, the instruction should require the learner to perform in such a way that a previously aquired cognitive skill is required; requiring the learner to analyze a problem in order to determine the type of answer needed involves the embedded skill of analysis To use a detached strategy, instruction should suggest to the learner that a particular cognitive skill be utilized as a means of organizing, storing, or retrieving information; suggesting that the learner draw a picture of a construct to help him/her remember it better involves a detached cognitive strategy. Both embedded and detached strategies should be incorporated within instruction. Attention-focusing devices which isolate particular cognitive skills should be utilized to increase learner awareness of the usefulness of those skills in manipulating knowledge. The constructs within a

particular subject area can provide an instance pool for teaching new cognitive skills. Once acquired, those skills should be overtly activated in instruction that encourages learners to apply the skills in manipulating content on their own.

Instruction should make overt those cognitive skills by which the content was prepared for the learners. Including references to particular skills during instruction will increase learners' facility with those skills as well as making learners more aware of how knowledge can be manipulated. Therefore, instruction in cognitive skills should accompany instruction in subject matter content.

REFERENCES

Ausubel, D.P. Some psychological aspects of the structure of knowledge. In S. Elam (Ed.), Education and the Structure of Knowledge. Chicago: Rand McNally, 1964.

Ausubel, D.P. A cognitive-structure theory of school learning. In L. Siegel (ed.), Instruction: Some Contemporary Viewpoints. San Francisco: Chandler Publishing Company, 1967.

Gagne, R.M. and Briggs, L.J. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1974.

Merrill, M.D. The Component Display Theory. In C.M.Reigeluth (Ed.), Instructional Design Theories and Models: An Overview of their Current Status, in press.

Merrill, M.D., Reigeluth, C.M., and Faust, G.W. The instructional quality profile: A curriculum evaluation and design tool. In H.F. O'Neill, Jr. (Ed.), Procedures for Instructional Systems Development. New York: Academic Press, 1979.

Merrill, M.D. and Wood, N.D. Instructional Strategies: A Preliminary Taxonomy. Columbus, Ohio: Ohio State University, 1974 (ERIC Document Reproduction Service No. SE 018 771).

O'Neill, H.F. Jr., (Ed.). Learning Strategies. New York: Academic Press, 1978.

Reigeluth, C.M. In search of a better way to organize instruction: the elaboration theory. Journal of Instructional Development, 1979, 2(3), 8-15.

Reigeluth, C.M., Merrill, M.D., and Bunderson, C.V. The structure of subject matter content and its instructional design implications. Instructional Science, 1978, 7, 107-126.

Reigeluth, C.M. and Rodgers, C.A. The elaboration theory of instruction: Prescriptions for task analysis and design. NSPI Journal, 1980, 19(1), 16-26.

Reigeluth, C.M., Merrill, M.D., Wilson, B.G., and Spiller, R.T. The Elaboration Theory of Instruction: A Model for Structuring Instruction, in press.

Rigney, J.W. Learning strategies: A theoretical perspective. In H.F. O'Neill (Ed.), Learning Strategies. New York: Academic Press, 1978.

RELATIONSHIP	STRATEGY
HIERARCHICAL - GENERALITY TO INSTANCE	INSTANTIATION
HIERARCHICAL - GENERALITY TO GENERALITY	ELABORATION
CO-ORDINATE - GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE	SYNTHESIS COMPARISON AND CONTRAST
ANALOGIC - GENERALITY TO GENERALITY	FAMILIARIZE
HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR	ACTIVATION OF COGNITIVE SKILLS

Figure 1. An Epitome

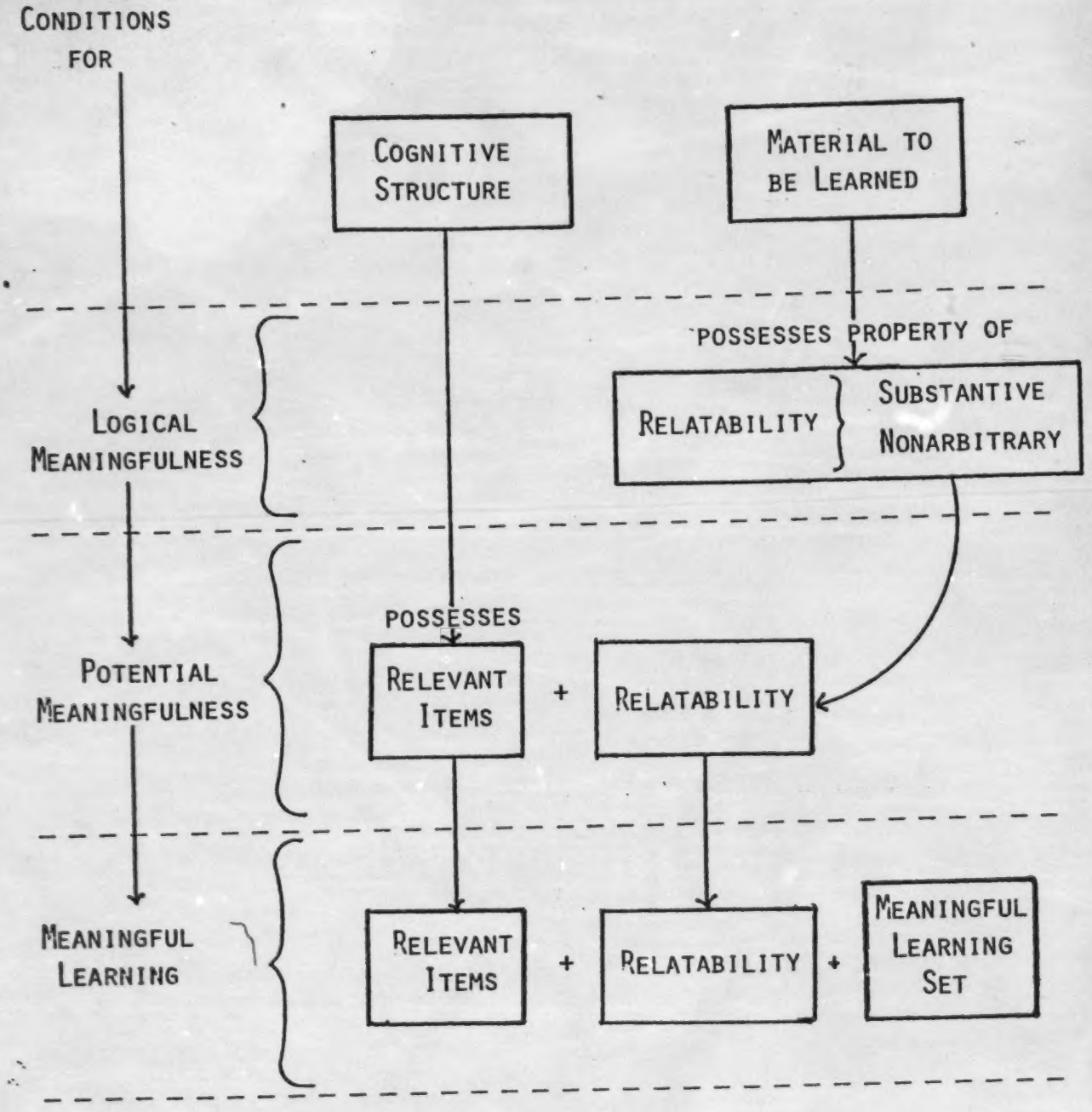
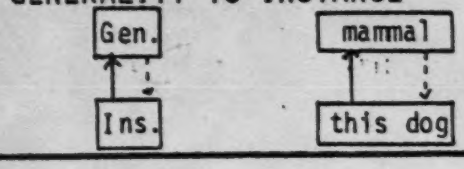
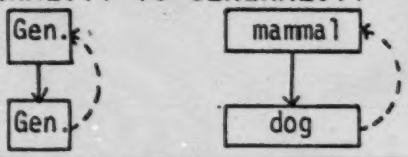
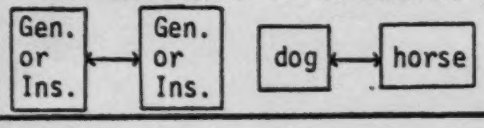
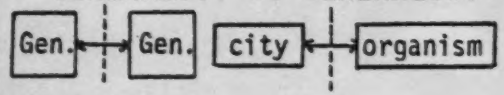
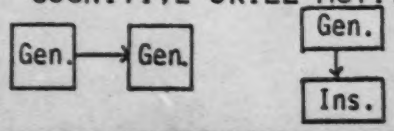


Figure 2. Requirements for logical meaningfulness, potential meaningfulness, and meaningful learning. (Ausubel, 1968, p.55)

		CONCEPT	PRINCIPLE
Meaningful		Find a generality Use a generality Remember a generality Remember an instance	Find a generality Use a generality Remember a generality Remember an instance
	FACT	SUBSET	PROCEDURE
Rote	Remember a fact	Find a generality Use a generality Remember a generality Remember an instance	Find a generality Use a generality Remember a generality Remember an instance
	Identity	Descriptive	Productive

Figure 3. The Content Matrix

RELATIONSHIP	STRATEGY	PROCEDURE
HIERARCHICAL- GENERALITY TO INSTANCE 		
HIERARCHICAL- GENERALITY TO GENERALITY 		
COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE 		
ANALOGIC- GENERALITY TO GENERALITY 		
HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR 		

BETWEEN SUBJECT-MATTER AREAS

WITHIN SUBJECT-MATTER AREAS

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Figure 4. Types of Relationships

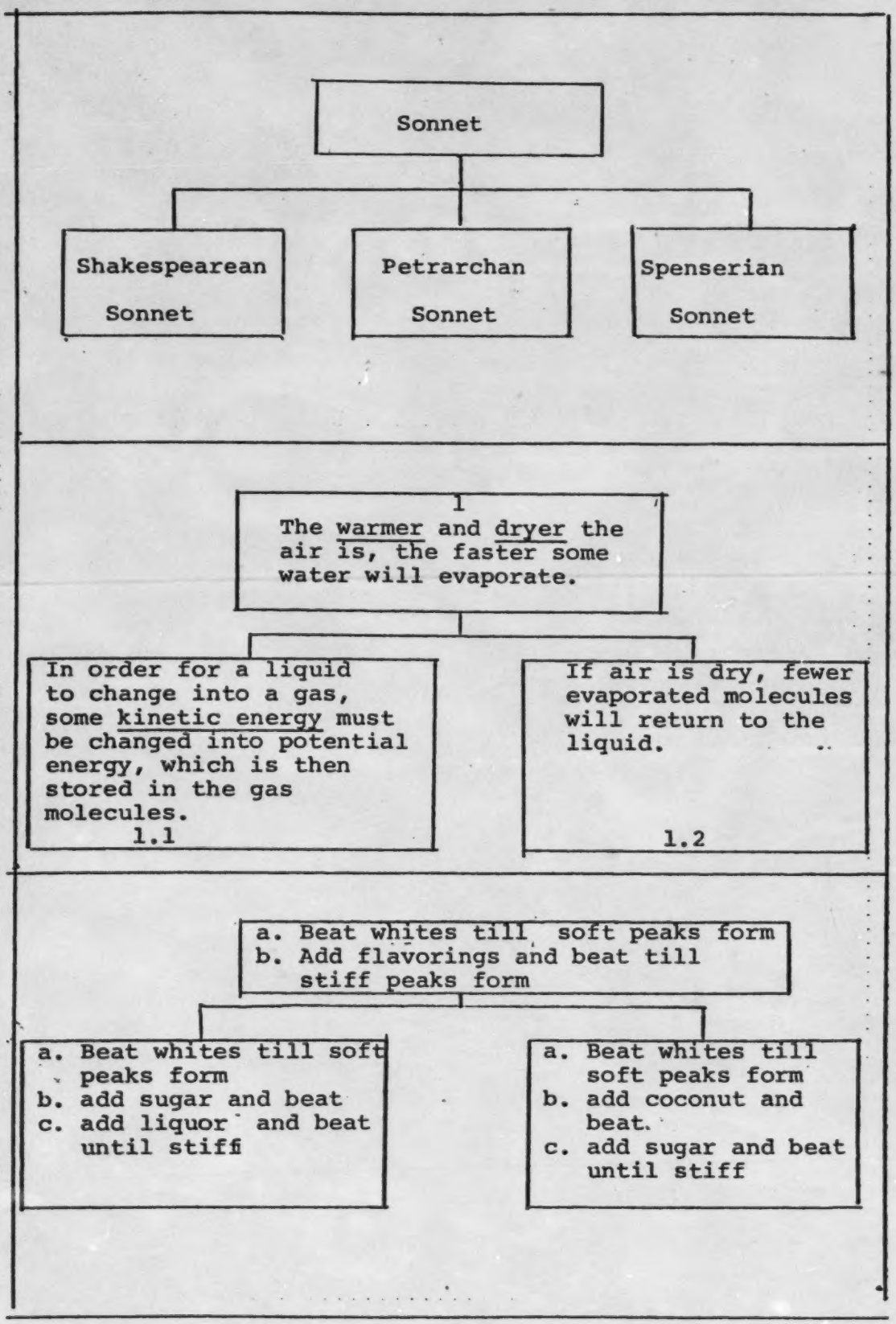
Kinds-Conceptual Structure
Sonnet
Shakespearean Sonnet
Petrarchan Sonnet
Spenserian Sonnet
Kinds-Theoretical Structure
1
The warmer and dryer the air is, the faster some water will evaporate.
In order for a liquid to change into a gas, some kinetic energy must be changed into potential energy, which is then stored in the gas molecules.
1.1
If air is dry, fewer evaporated molecules will return to the liquid.
1.2
Kinds-Procedural Structure
a. Beat whites till soft peaks form
b. Add flavorings and beat till stiff peaks form
a. Beat whites till soft peaks form
b. add sugar and beat
c. add liquor and beat until stiff
a. Beat whites till soft peaks form
b. add coconut and beat.
c. add sugar and beat until stiff

Figure 5. Hierarchical Structures Among Generalities

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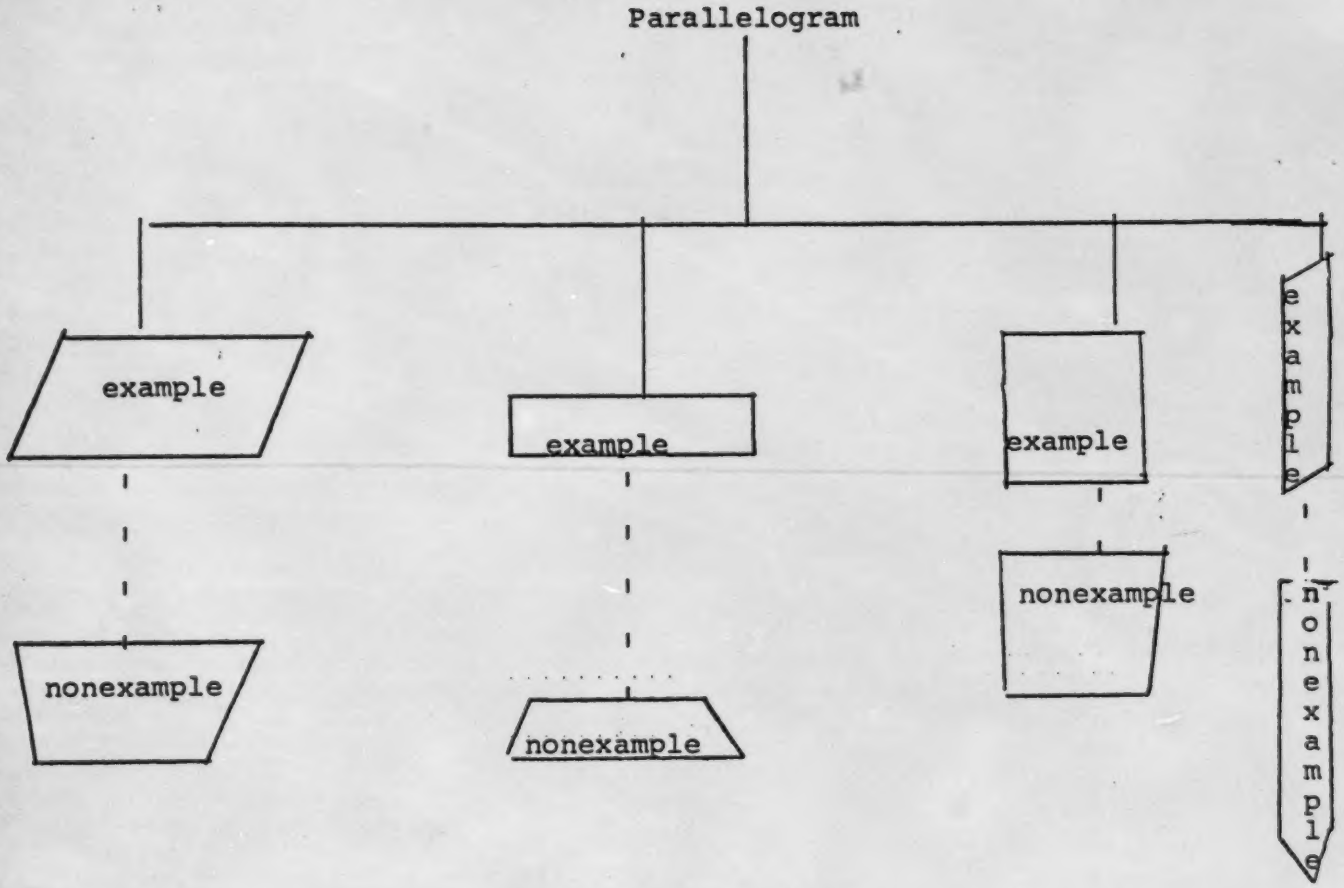


Figure 6. Comparing and Contrasting Instances

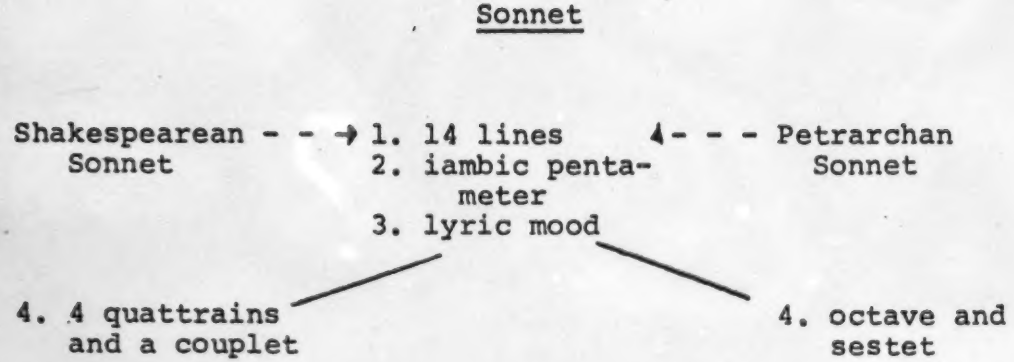


Figure 7. Comparing and contrasting co-ordinate generalities

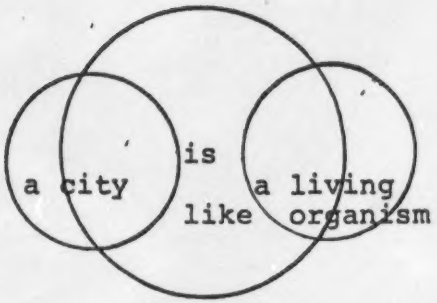


Figure 8. Using analogic relationships

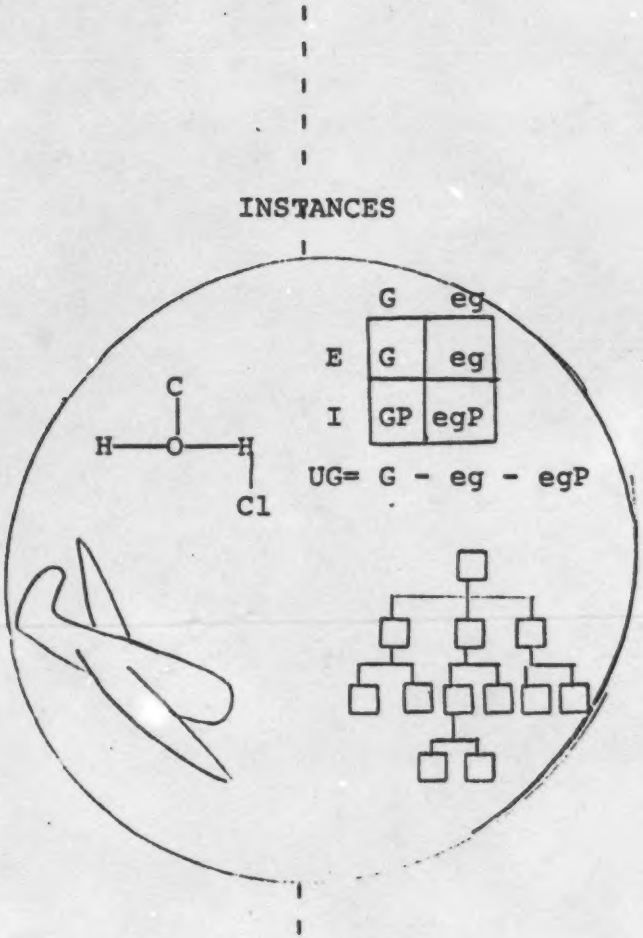


Figure 9. Activating Cognitive Skills

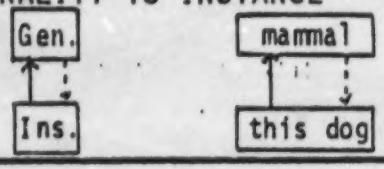
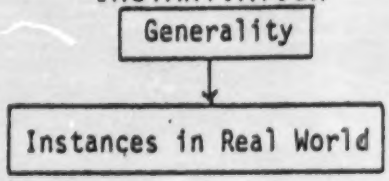
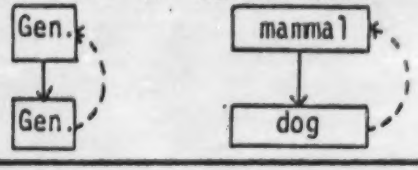
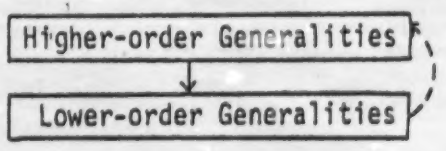
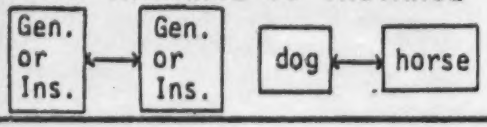
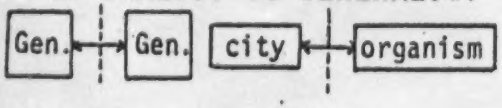
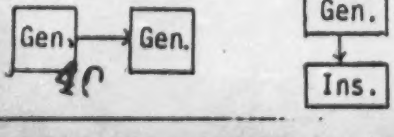
RELATIONSHIP	STRATEGY	PROCEDURE
HIERARCHICAL- GENERALITY TO INSTANCE 	INSTANTIATION 	
HIERARCHICAL- GENERALITY TO GENERALITY 	ELABORATION 	
COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE 		
ANALOGIC- GENERALITY TO GENERALITY 		
HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR 		

Figure 10. Strategies for Utilizing Hierarchical Relationships

	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE Gen. → Ins. mammal → this dog	INSTANTIATION Generality ↓ Instances in Real World	
	HIERARCHICAL- GENERALITY TO GENERALITY Gen. → Gen. mammal → dog	ELABORATION Higher-order Generalities ↓ Lower-order Generalities	
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE Gen. or Ins. ↔ Gen. or Ins. dog ↔ horse	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY Gen. ↔ Gen. city ↔ organism		
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR Gen. → Gen. Gen. ↓ Ins.		

Figure 11. A Strategy for Utilizing Co-ordinate Relationships

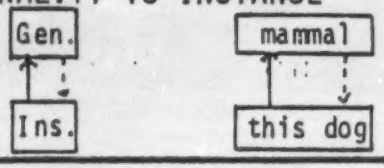
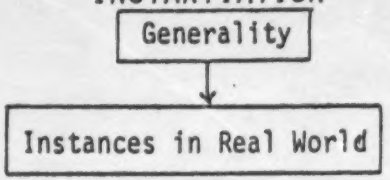
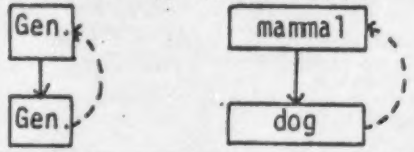
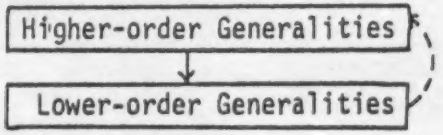
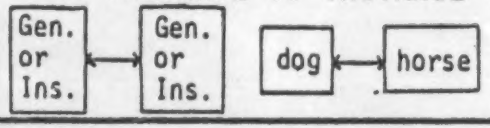
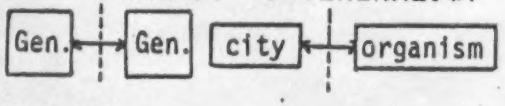
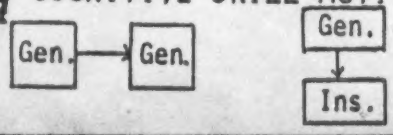
	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE  	INSTANTIATION  	
	HIERARCHICAL- GENERALITY TO GENERALITY  	ELABORATION  	
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE  	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY  	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR  		

Figure-12.--Analogy as an Instructional Strategy

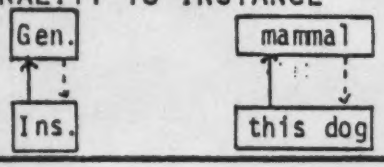
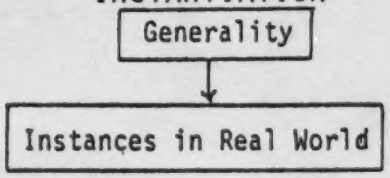
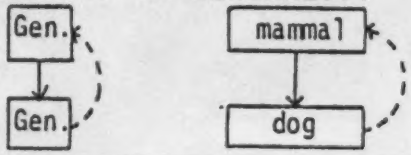
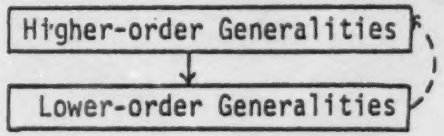
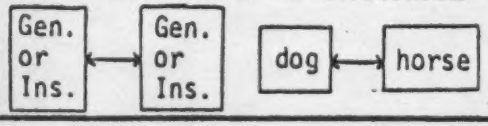
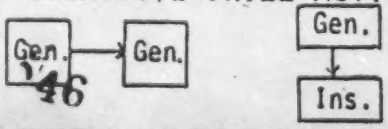
RELATIONSHIP	STRATEGY	PROCEDURE
HIERARCHICAL- GENERALITY TO INSTANCE 	INSTANTIATION 	
HIERARCHICAL- GENERALITY TO GENERALITY 	ELABORATION 	
COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE 	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	
ANALOGIC- GENERALITY TO GENERALITY	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	
HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR 	ACTIVATION OF COGNITIVE SKILLS Use of Cognitive Skills to Manipulate or Process Information	

Figure 13. Activation of Cognitive Skills.

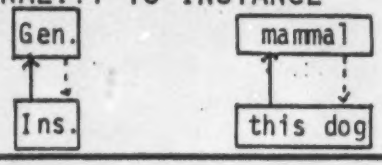
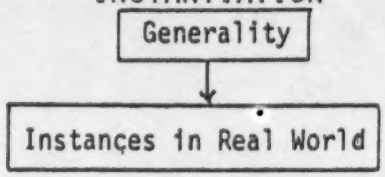
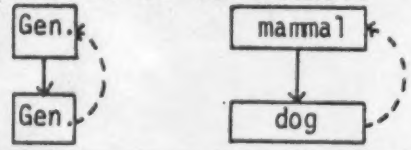
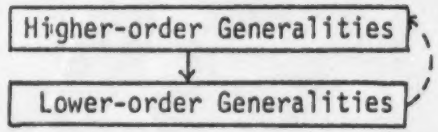
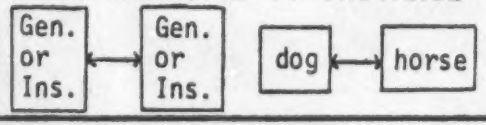
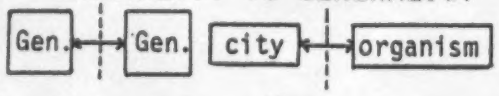
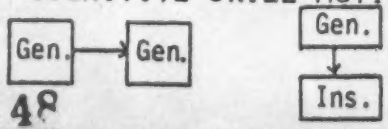
	RELATIONSHIP	STRATEGY	PROCEDURE
WITHIN SUBJECT-MATTER AREAS	HIERARCHICAL- GENERALITY TO INSTANCE  	INSTANTIATION  	1) Range of Difficulty 2) Divergence 3) Attribute Isolation 4) Alternative Representation
	HIERARCHICAL- GENERALITY TO GENERALITY  	ELABORATION  	1) Determine Orientation Structure 2) Construct Epitome 3) Construct Elaborated Structure-Simple-Complex, General-Detailed
	COORDINATE- GENERALITY TO GENERALITY OR INSTANCE TO INSTANCE  	SYNTHESIZE Among Generalities in Single Subject COMPARE & CONTRAST Instances In a Single Generality	1) Identify Type of Relationship 2) Internal Synthesis 3) External Synthesis 1) Matched Non-Examples&Examples 2) Alternative Representation 3) Divergence
BETWEEN SUBJECT-MATTER AREAS	ANALOGIC- GENERALITY TO GENERALITY  	FAMILIARIZE Identification of Shared Critical Attributes of Generalities in Differing Subject Matter Areas	1) Analogue of Same Content Type 2) Articulate Critical Attributes 3) Identification of Limitations Of the Analogy
	HIERARCHICAL* *COGNITIVE SKILL ACTIVATOR  	ACTIVATION OF COGNITIVE SKILLS Use of Cognitive Skills to Manipulate or Process Information	1) Embedded Strategy Method 2) Detached Strategy Method

Figure 14. Designing Instruction that Makes Content Meaningful